# BIODIVERSITY OF TROPICAL POLYCLAD FLATWORMS FROM THE GREAT BARRIER REEF, AUSTRALIA

L.J. NEWMAN AND L.R.G. CANNON

Newman, L.J. & Cannon, L.R.G. 1994 06 30: Biodiversity of tropical polyclad flatworms from the Great Barrier Reef, Australia. *Memoirs of the Queensland Museum* 36(1): 159-163. Brisbane. ISSN 0079-8835.

Prior to our work, only 16 polyclad flatworms had been recorded from the entire Great Barrier Reef. In the past, these delicate worms proved difficult to collect and virtually impossible to fix. Since 1989, we have documented 134 species of polyclads (over 90% new) from two locations in the southern Great Barrier Reef. These results indicate that the biodiversity of tropical marine polyclads is much greater than was previously thought. ☐ *Platyhelminthes, Polycladida, flatworm, colour pattern, biodiversity, Australia, Great Barrier Reef.*

*L.J. Newman & L.R.G. Cannon, Worms Section, Queensland Museum, PO Box 3300, South Brisbane, Queensland, Australia 4101; 31 August 1993.*

Marine polyclad flatworms (Platyhelminthes, Polycladida) are often regarded as conspicuous inhabitants of tropical reefs yet surprisingly little is known about either their biology or diversity. Tropical polyclads are known as pests of oysters (Stead, 1907) and giant clams (Newman, et al., 1993), associates of soft corals (Cannon, 1990), brittlestars (Cannon & Grygier, 1991), molluscs, crustaceans, echinoderms and corals (see Prudhoe, 1985). Less than 20 studies have considered Australian polyclads (e.g. Hyman, 1959; Prudhoe, 1977, 1982; Cannon, 1990; Cannon & Newman, 1993) and only 16 species are recorded from the Great Barrier Reef (GBR)(Haswell, 1907; Prudhoe, 1985; Cannon & Newman, 1993; Newman et al., 1994) — and of these species, only two have been described since 1907.

The diversity of tropical polyclads is poorly understood for a variety of reasons. Firstly, many descriptions are based on single, immature, preserved specimens or even only on water colour illustrations. Secondly, polyclads are rarely collected intact since they tend to fall apart when stressed and as a consequence they are inadequately represented in museum collections. Furthermore, seldom have their colour patterns been adequately recorded. Finally, the habitats and biology of these flatworms are poorly known.

The colourful pseudocerotid polyclads have been previously identified on the basis of their colour pattern (Hyman, 1954, 1959; Prudhoe, 1985, 1989) and confusion has arisen over the reliability of this for species descriptions. According to Prudhoe (1985) colour and markings are the only means by which pseudocerotids can be identified (although this was often poorly recorded). Conversely, Faubel (1983, 1984) maintained that the comparative morphology of the reproductive system was an essential tool for species diagnosis for turbellarians. Serial reconstruction of the male and female reproductive structures is time consuming and has not been consistently used for species descriptions.

## POLYCLADS PRESENT

We collected polyclads by hand from under coral rubble at the reef crest and under ledges from the reef slope at Heron and One Tree Islands, southern GBR, from 1989 to 1993. All species were examined live before fixation and their colour patterns recorded photographically either in situ or in the laboratory.

Our study of tropical polyclads has been greatly enhanced by the development of a new fixation technique which ensures animals are preserved flat, intact and retain their colour patterns (Newman & Cannon, in press). Over 800 specimens (wholemounts and serial sections) with colour transparencies are lodged at the Queensland Museum. For species descriptions we have relied on examination of morphological characters of living animals, colour pattern and on reconstruction of the reproductive anatomy from longitudinal serial sections of mature animals.

To date, 134 species belonging to 6 families (Suborders Acotylea and Cotylea) of marine polyclads have been collected from the southern Great Barrier Reef (GBR). We considered 123 species (over 90%) to be new (Table 1) with two new genera and one new family.

Comparison of collecting data showed that the number of species collected per sampling trip did not diminish with time. Overall, 1.3 to 3.0 species

TABLE 1. Summary of polyclads collected from Heron and One Tree Islands.

| Order & Family | Genus | # Spp. known | # Spp. 'new' |
|---|---|---|---|
| Suborder Cotylea | | | |
| Pseudocerotidae | | | |
| | *Pseudoceros* | 5 | 45 |
| | *Pseudobiceros* | 4 | 8 |
| | Nov. genus # 1 | 0 | 8 |
| | Nov. genus # 2 | 0 | 7 |
| | *Thysanozoon* | 0 | 2 |
| | *Acanthozoon* | 0 | 1 |
| | unidentified | 0 | 14 |
| Euryleptidae | | | |
| | *Eurylepta* | 1 | 7 |
| | *Cycloporus* | 0 | 8 |
| Nov. Family # 1 | | 0 | 1 |
| Suborder Acotylea | | | |
| Callioplanidae | | 1 | 2 |
| Planoceridae | | 0 | 10 |
| Stylochidae | | 0 | 2 |
| | unident. acotyleans | 0 | 7 |
| | Total no. spp. | 11 | 123 |

were collected per sampling day and the number of new species collected per sampling day ranged from 0.4 to 2.2 (Table 2). The cumulative total of new species also rose steadily with each trip and this number is predicted to continue to increase with time by the curve (Fig. 1). These results indicate that more new species can be expected be found from the southern GBR (Fig. 1). Interestingly, all of the previously known species were collected during the first sampling trip and remained virtually constant over time.

The most diverse and abundant polyclads from the southern GBR belong to the Pseudocerotidae, which are generally the most flamboyantly coloured flatworms. The Euryleptidae were the second most diverse family: these worms were also found to be flamboyantly coloured, often

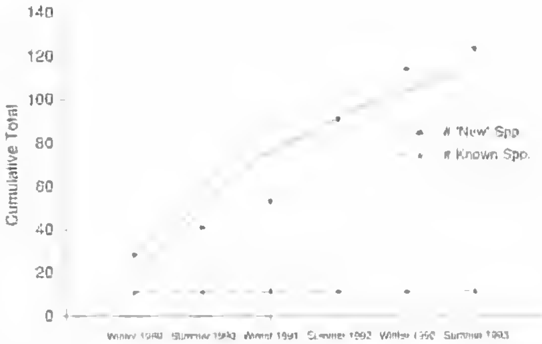


FIG. 1. Cumulative totals of known and 'new' species from Heron and One Tree Islands (1989-1993).

possessing similar colour patterns to the pseudocerotids (Fig. 2). The Planoceridae were the most abundant group of acotyleans: these polyclads were generally cryptic, avoiding sunlight and consequently were more difficult to find.

Colour documentation of living flatworms has proven critical to the study of tropical polyclads. Results showed that similar colour patterns occurred in: (1) different families, viz, Pseudocerotidae and Euryleptidae (Fig. 2 A,B); (2) in different genera, viz., *Pseudoceros* and *Pseudobiceros* (Fig. 2 C,D); and (3) two genera where the pattern is the same but the colour is reversed *Pseudoceros* and *Pseudobiceros* (Fig. 2 E,F).

Field observations showed that the most common polyclads, the pseudocerotids, were found feeding on a variety of colonial ascidians evidently showing nonspecificity in their diet. During feeding, pseudocerotids expand the folds of their highly ruffled pharynx into the individual zooids of colonial ascidians. Worms collected under boulders at the reef crest often left feeding scars when they were removed from their prey and one species was consistently collected from within the test of its prey, an ascidian. Pseudocerotids did not feed in aquaria and further study of preferences may be hampered by the difficulty in keeping ascidians healthy in aquaria. No other prey was observed being consumed although

TABLE 2. Summary of collecting data from Heron and One Tree Islands.

| Collecting trip | Total # spp. | # Spp. known | # 'New' spp. | # Sampling days | Total # spp./day | # 'New' spp./day. |
|---|---|---|---|---|---|---|
| Winter 1989 | 39 | 11 | 28 | 22 | 1.8 | 1.3 |
| Summer 1990-91 | 15 | 0 | 13 | 6 | 2.5 | 2.2 |
| Winter 1991 | 22 | 0 | 12 | 17 | 1.3 | 0.7 |
| Summer 1991-92 | 66 | 0 | 38 | 23 | 3.0 | 1.7 |
| Winter 1992 | 57 | 0 | 23 | 35 | 1.6 | 0.7 |
| Summer 1992-93 | 51 | 0 | 9 | 23 | 2.2 | 0.4 |

these polyclads were also found on sponges and coralline algae. Callioplanids, however, were found on several occasions in the field with a small intact gastropods, *Turbo perspeciosus* (Iredale, 1929), in their pharynx or digestive tract.

## POLYCLADS FUTURE

Despite their relatively large size (average of 20-50mm) and their conspicuous and flamboyant colour patterns, polyclads were poorly repre-

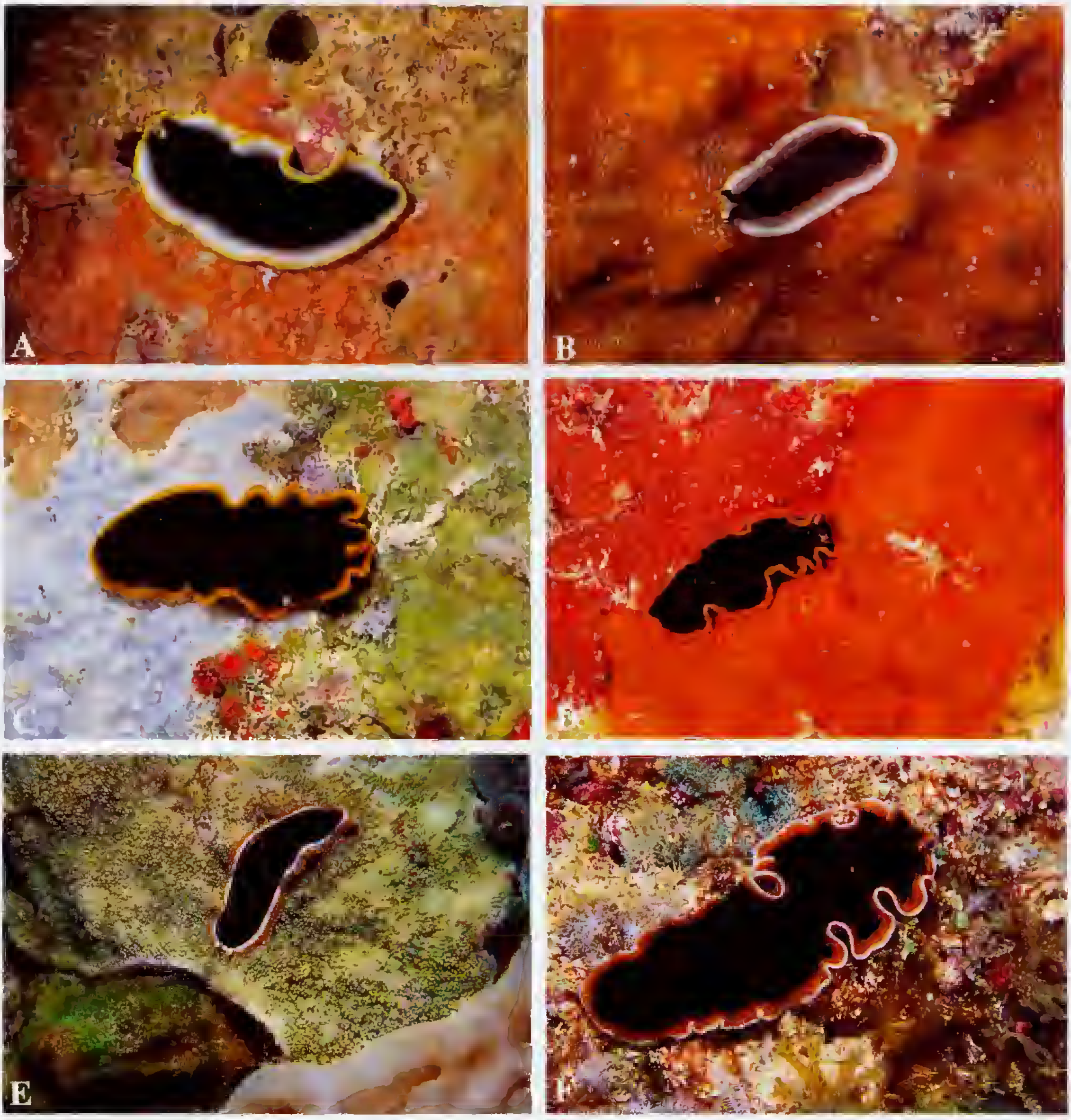

FIG. 2. Colour variation in cotyleans. Between families: A, Pseudocerotidae; B, Euryleptidae. Between genera: C, *Pseudoceros* sp.; D, *Pseudobiceros*. Colour reversal between genera: E, *Pseudoceros* sp.; F, *Pseudobiceros hancockanus* (Collingwood, 1876).

sented from tropical waters of the GBR (Prudhoe, 1985; Cannon & Newman, 1993; Newman et al., 1994). Clearly any inference that the small number of currently described species indicates low polyclad diversity in these tropical waters is wrong. Our results have shown that the flatworm fauna is extremely diverse at Heron and One Tree Islands and over 90% of the animals collected have not been described. This is the highest diversity for these worms recorded for one location in the world. Furthermore, the notion that these marine invertebrates may be rare and difficult to find has been proven false by our demonstrated success in collecting.

Examination of live animals has provided the opportunity to document new morphological characters such as pharynx shape and size, marginal tentacle shape and marginal and cerebral eye arrangement. As a consequence, these new taxonomic characters are being used to redescribe known species, describe new species and designate new genera.

The improved fixation techniques and the use of colour photography and field observations on live animals has enabled us to recognise new characters, which, together with reconstruction of the reproductive anatomy, will enable new taxa to be described.

We have shown, for example, that the same colour pattern can occur in different genera and even in different families. Colours have also been found reversed between different genera. These results show that colour pattern cannot reliably be used to differentiate genera or families. Whether colour pattern alone can be used to separate species remains unanswered without further study and comparisons made of the reproductive structures.

The biological significance of flamboyant colours in polyclads may be related to the toxicity of these worms. Several polyclads are reported to contain toxins such as tetrodotoxin (Halstead, 1978; Miyazawa et al., 1986; Flowers, pers. comm.). Further studies are needed on chemical defence in polyclads in order to determine which groups are toxic. Certainly, some pseudocerotids are known to mimic toxic opisthobranch molluscs (Brunckhorst, 1988; Gosliner & Behrens, 1990; Newman et al., 1994).

The true diversity of tropical marine polyclads is now just being recognised. Increased awareness of polyclad diversity is related to new fixation techniques, accessibility to the reef, and recognition of the importance of live study and photography to determine habits, habitus and habitats.

## ACKNOWLEDGMENTS

Many people assisted in the delicate task of collecting polyclads; we would especially like to thank; Mr A. Flowers, Ms M. Preker, Mr H. Peterken, Ms S. Whittingham and Mrs J. Marshall. Mr A. Flowers helped immensely with collecting and photography; Ms Z. Khalil and Ms C. Lee did the histological preparations, and Mr B. Cowell helped with the colour plate. Kim Sewell and Peter Davie made useful comments on the manuscript. We are also grateful to the Heron Island Research Station Director and the Managers of the One Tree Island Research Station. Dr I. Lawn and Ms M. Preker are thanked for their support and advice. This project was generously supported by P&O Pty Ltd/Heron Island Research Station Reef Fellowship (to L.N.) and the Australian Research Council Grant # AD 90318306 (to L.R.G.C.).

## LITERATURE CITED

BRUNCKHORST, D.J. 1988. Amazing aposematic phyllidiid nudibranchs — some interdisciplinary perspectives. P.88, In Proceedings of the Australian Marine Science Association Jubilee Conference, Sydney, December 1988.

CANNON, L.R.G. 1990. *Apidioplana apluda* n.sp., a new polyclad turbellarian symbiote of gorgonian corals from the Great Barrier Reef, with a review of the family Apidioplanidae. Memoirs of the Queensland Museum 28: 435-442.

CANNON, L.R.G. & GRYGIER, M.J. 1991. The turbellarian *Notoplana comes* n. sp. (Leptoplanidae: Acotylea: Polycladida) found with the intertidal brittle star *Ophiocoma scolopendrina* (Ophiocomidae: Ophiuroidea) in Okinawa, Japan. Galaxea 10: 23-33.

CANNON, L.R.G. & NEWMAN, L.J. 1993. Polycladida. Pp. 82-83, Pl. 4. In Mather, P. & Bennett, I. (eds), 'A coral reef handbook.' (Surrey Beatty and Sons: Sydney).

FAUBEL, A. 1983. The Polycladida, Turbellaria. Proposal and establishment of a new system. Part I. The Acotylea. Mitteilungen aus dem hamburgischen zoologischen Museum und Institut 80: 17-121.

1984. The Polycladida, Turbellaria. Proposal and establishment of a new system. Part II. The Cotylea. Mitteilungen aus dem hamburgischen zoologischen Museum und Institut 81: 189-259.

GOSLINER, T.M. & BEHRENS, D.W. 1990. Special resemblance, aposematic colouration and mimicry in opisthobranch gastropods. Pp. 127-

138. In Proceedings of a Symposium Sponsored by the American Society of Zoologists, June 1990.
HALSTEAD, B.W. 1978. 'Poisonous and venomous marine animals of the World. Vol. 1.' (The Darwin Press: Princetown, New Jersey).
HASWELL, W.A. 1907. Observations on Australian polyclads. Transactions of the Linnean Society, London (2) Zoology 9: 465-485.
HYMAN, L. H. 1954. The polyclad genus *Pseudoceros*, with special reference to the Indo-Pacific region. Pacific Science 8: 219-225.
1959. Some Australian polyclads. Records of the Australian Museum 25: 1-17.
MIYAZAWA, K., JOEN, J.K., MARUYAMA, J., NAGUCHI, T., ITO, K. & HASHIMOTO, K. 1986. Occurrence of tetrodotoxin in the flatworm *Planocera multitentaculata*. Toxicon 24: 645-650.
NEWMAN, L.J. & CANNON, L.R.G. ( in press). The importance of fixation of colour, pattern and form in tropical Pseudocerotidae (Platyhelminthes, Polycladidia). Hydrobiologia.
NEWMAN, L.J., CANNON, L.R.G. & BRUNCKHORST, D.J. 1994. A new flatworm (Platyhelminthes, Polycladida) which mimics a phyllidiid nudibranch (Mollusca, Nudibranchia). Zoological Journal of the Linnean Society 110: 19-25.
NEWMAN, L.J., CANNON, L.R.G. & GOVAN, H. 1993. *Stylochus (Imogene) matatasi* n. sp. (Platyhelminthes, Polycladida): Pest of cultured giant clams and pearl oysters from Solomon Islands. Hydrobiologia 257: 185 - 189.
PRUDHOE, S. 1977. Some polyclad turbellarians new to the fauna of the Australian coasts. Records of the Australian Museum 31: 586-604.
1982. Polyclad turbellarians from the southern coasts of Australia. Records of the South Australian Museum 18: 361-384.
1985. 'A monograph on polyclad Turbellaria'. (Oxford University Press: Oxford).
1989. Polyclad turbellarians recorded from African waters. Bulletin of the British Museum, Natural History (Zoology) 55: 47-96.
STEAD, D.G. 1907. 'Preliminary note on the wafer (*Leptoplana australis*), a species of dendrocoelous turbellarian worm, destructive to oysters'. (Department of Fisheries, New South Wales: Sydney).